Zambia Electricity Cost of Service Study

Task 6 – Life-line Tariff Mechanism

prepared for

Energy Regulation Board

with the support of the African Development Bank

Submitted by

Energy Market and Regulatory Consultants Limited (part of the MRC Group)

Final Report

10th December 2021

Forth House, 28 Rutland Square, Edinburgh, EH1 2BW, UK

tom.jardine@energy-mrc.com

Table of Contents

Acronyms

Acronym	Description
AE	Adult Equivalent
AfDB	African Development Bank
AVG	Average
BCN	Basic Consumption Needs
HH	Household
IBT	Increasing Block Tariffs
kWh	Kilowatt-hour
LCMS	Living Conditions Monitoring Survey
SSA	Sub Saharan Africa
VDT	Volume Differentiated Tariffs
WB	World Bank
ZMW	Zambian Kwacha

List of Tables

List of Figures

1. Executive Summary

The objective of this report is to

- Propose a tariff level for low income household consumers, including the appropriate quantity of electricity required for basic needs; and
- Provide recommendations on how the life-line tariff subsidy could be paid for without government transfers and reduction in revenues of the utility.

1.1. Methodology

When implementing a life line tariff scheme, particular attention must be given to properly define electricity affordability. Affordability is related to the ability of certain consumers or groups of consumers to pay a minimum level of service. Therefore, affordability is a concept intimately related to poverty.

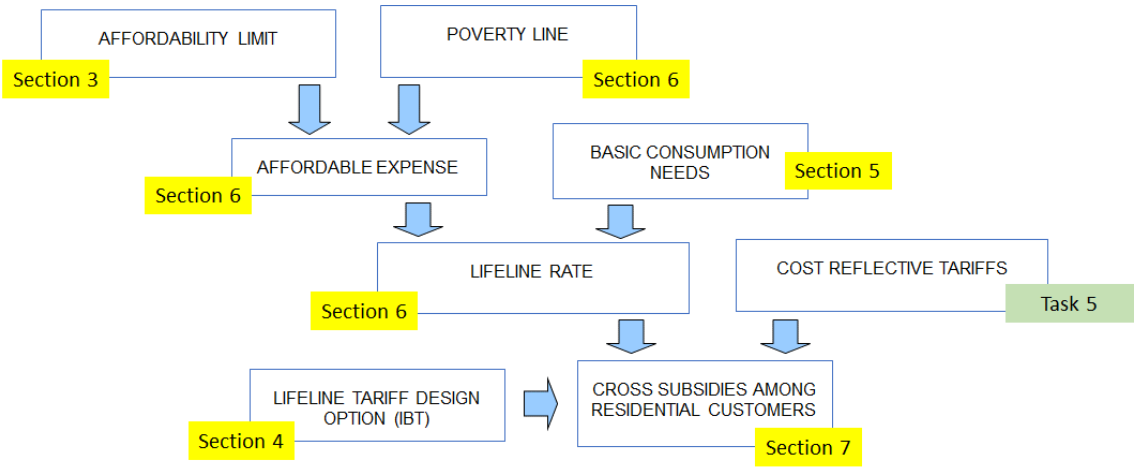
Electricity affordability is assessed through the portion (share) of monthly income or expenses of households that is spent on electricity service. The use of household expenditure tends to provide more accurate information than household income when informal activity represents a part of household income.

First, a referential value (threshold) of affordability must be defined. Although there is no universal benchmark, an acceptable threshold for electricity to be considered for Zambia may be around 3.6% of poor household expenditures.

Then it is necessary to define a level of subsistence electricity consumption or some other value considered acceptable. From this information it is possible to determine an average tariff value that is affordable for the household/consumer.

After defining these parameters, the overall amount of the subsidy that needs to be recovered can be estimated through increases in charges in other tariff categories. In order to do this, the implementation of 3 blocks of consumption in the domestic tariff is proposed.

The following diagram represents the general approach for the task and how it is addressed along the report:



1.2. Affordability

Affordability is defined as the share of monthly household income spent on utility services, such as electricity, district heating and water. It is often defined more precisely as an affordability ratio - the share of utility payments in total household expenditures. Using household expenditures rather than income tends to provide more accurate information, as household income data rarely captures all sources of revenue. This is particularly the case in countries where informal activity provides a substantial share of household income, which is the case in Zambia. In these countries, expenditure is a more reliable indicator of the resources available for households to afford utility services.[1]

A comparative table of proportions of expenditures by households on electricity across the Sub-Saharan countries indicates an average of about 4.4% for poor households and 3.6% for all households. For the purpose of defining the Lifeline Tariff for Zambia, we will adopt 3.6% (i.e the all household's average of the region) as the affordability limit, thereby providing a fair target, at the average regional level, for the electricity consumption burden on poor households' expenditures.

[1] Fankhauser, Samuel and Tepic, Sladjana (May 2005). Can por consumers pay for energy and water? An affordability analysis for transition countries. European Bank for Reconstruction and Development. Wingler, Harald; Simoes, André Felipe; Lebre La Rovere, Emilio; Atiq Rahman, Mozaharul Alam and Mwakasonda, Stanford (2011). Access and affordability of electricity in Developing countries. World Development Vol. 39, N° 6, pp. 1037 - 1050.

1.3. Lifeline Tariffs Design

The costs (or lost revenue by the utility) as a result of the application of the lifeline tariff can be recovered through cross-subsidisation in the tariff structure. In a tariff structure that is fully cost-reflective as the one designed in Task 5, the introduction of a lifeline tariff would require one or more of the other tariffs to be higher than their cost-reflective level so that the income lost to the utility from the application of the lifeline tariff is recovered from other tariff category consumers.

Cross-subsidisation from productive categories (i.e., industrial, commercial) can have long-term negative impacts on the competitiveness of business especially for electricity intensive industries. **To avoid such negative commercial effects it is preferable if the cross-subsidisation is carried out between low- and high-income households rather than industrial or commercial customers**.

The most common system for introducing a lifeline tariff is based on the first tranche of consumption. This type of regime is called **Increasing Block Tariffs** (IBTs), where consumers face higher unit prices on higher blocks of consumption. The first block is the lifeline tariff and this is the case in the current ZESCO tariff schedule.

An alternative design is the so-called **Volume-Differentiated Tariff**s (VDTs) where kWh consumption above a threshold leads to a higher price on all consumption. The VDT structure is an effective method to efficiently target lifeline blocks, thus reducing costs associated with subsidy schemes for the poorest. Correct calibration of block sizes and associated price levels requires a good knowledge of consumption patterns. In addition to this, there are very sharp tariff increases when moving into a higher consumption block, generating undesirable variability in tariffs faced by customers.

The IBT system is the most commonly applied particularly in the developing world and is currently applied in Zambia. VDT would require significant advances in the metering endowment in Zambian residential customers (currently almost 100% pre-paid based) and would represent a drastic change to the current regime. **We are therefore assuming and recommend that the IBT system will continue to be applied in Zambia.**

We suggest life line tariffs be designed and applied not just for current ZESCO low income customers but for all low income households in the country.

1.4. Basic Consumption Needs

The volume of consumption to be subsidized varies across countries and regions. The table below lists some relevant examples of subsidized electricity consumption under lifeline rates (social tariff regimes) by country.

Social Tariff Subsidized Electricity Consumption. African Sub-Saharan Region

Country	Monthly Consumption for Social Tariff
Angola	TS1=120 KWh / TS2=200 KWh
Mozambique	100 KWh
Togo	40 KWh
Tanzania	75 KWh
South Africa	150 KWh
Nigeria	50 KWh
Niger	50 KWh
Ghana	50 KWh
Gabon	TS1=120 KWh / TS2=240 KWh
Benin	20 KWh

Source: World Bank, 2016

Given the non-existence of recent energy consumption surveys or information on Zambian households to determine a level of basic consumption needs applicable for this study, we are going to assume indirect references from SSA (presented in the table above). Therefore, referring to the literature on regional energy needs in southern countries of Africa, a referential consumption of 50 kWh/month can be adopted as the Basic Consumption Needs level to apply for the lifeline rate estimation in Zambia.

According to our experience, this regional reference of 50kWh/month Basic Consumption Needs may be approximately disaggregated between four main groups of uses (lighting, radio, cell phones and cooking/water heating/ironing) as presented in the following table:

Dissagregation of Basic Consumption Needs

Use	h/day	# devices	W/device	days	Total (kWh)
Lighting	5.00	2	60.0	30	18.0
Radio	10.00	1	3.0	30	0.9
Cell phones	1.00	2	4.0	30	0.2
Cooking/water heating/ironing	1.03	1	1,000	30	30.9
TOTAL					**50.0**

Source: EMRC estimations

The following table presents the number of households and consumption levels under the 50kWh proposed lifeline block and the current 100 kWh lowest consumption block:

Volume of subsidized energy sales for domestic customers for 50 and 100/kWh definition of basic electricity needs

Basic Consumption Needs	50 kWh/month	100 kWh/month
Numbers of Residential customers within basic needs band	22,908	40,167
Numbers of Residential customers that consume more than the basic needs band	691,248	673,989
Residential customers within basic needs band	3.2%	5.6%
Average life-line consumption (kWh/month)	35.2	53.7
Total average consumption (kWh/month)	326.9	326.9
Total basic needs consumption (kWh/month)	807,332	2,157,776
Total consumption - all domestic customers (kWh/month)	233,440,393	233,440,393
Basic Consumption Needs as a % of total residential consumption	0.35%	0.92%

Source: EMRC estimation based on ZESCO information (2018)

The subsidized number of customers and their energy consumption in 2018 was moderate and therefore would be relatively easy to accommodate within the ZESCO system. However, the impact may become more important in the future because the number of low-income end users from rural areas that will be connected to the grid may increase significantly as connection programmes develop. The level of subsidies will increase *pari passu* as the number of low-income end users connected to the grid increases. Thus the financial burden of subsidies will need to be monitored closely on a regular basis particularly if grid-connected electrification adds large numbers of low-income households to the network.

1.5. Lifeline Energy Rate

To determine the average income of a household in poverty it is necessary to consider the average expenditure in the households in the quintiles with a per capita income lower than the 214 ZMW/AE/month estimated by LCMS. The following table shows graphically this comparison:

Expenditure quintiles below poverty line

Quintile	Households	AVG monthly exp. (ZMW/month)	AVG household size (AE)	AVG exp. (ZMW/AE/month)	
Q1	20%	227.0	4.4	72.0	
Q2	20%	486.0	4.9	133.0	Poverty line 214.0 ZMW/AE/month
~~Q3~~	~~20%~~	~~842.0~~	~~5.2~~	~~218.0~~	
Q4	20%	1,525.0	5.3	374.0	
Q5	20%	4,856.0	5.8	1,144.0	
Total	100%	1,588.0	5.1	388.0	

Source: EMRC based on LCMS 2015

The average expenditure in quintiles below the poverty level of 214 ZMW/AE/month corresponds to the average of Q1, Q2 and Q3 quintiles: 141/AE/month (average poverty expenditure). This amount must be adjusted by inflation to measure it in 2019 ZMW, and multiplied by the average household size in Q1, Q2 and Q3 (4,8 AE/HH), deriving a final figure for poverty level household expenditure of 934 ZMW/HH.

As a conclusion, the maximum affordable household expenditure in electricity for an average household below the poverty line is 3.6% of 939.5 ZMW/month = 33.8 ZMW/month in 2019, including taxes. As per ERB tariff schedule, applicable taxes are 3% excise duty and 16% VAT, so the affordable monthly household expenditure excluding taxes is 28.3 ZMW.

Thus, the level of consumption equal to the life-line threshold of 50 kWh may be afforded by an average household below the poverty line if a life-line tariff is set at or below 0.56 ZMW/kWh (exclusive of taxes). Lower consumptions would reach electricity expenditure shares below 3.6%.

1.6. Subsidy Regime among Residential Customers

To fully determine the Life Line tariff level it is first necessary to establish the source of funding of the subsidy that customers under life-line consumption are going to receive.

Subsidies can be directly financed by the government from general tax revenues, or regulators can make use of cross-subsidization within their electricity customer base. Even though direct finance fom the government to households may be desirable because it does not distort the efficient pricing structure, its implementation requires complex fiscal procedures and accurate and updated information on households wealth situation that imposes a significant burden on developing countries in Latin America and SSA. This is why subsidy-related costs (or lost revenue by the utility) as a result of the application of the lifeline tariff are usually recovered through cross-subsidisation in the electricity tariff structure.

Thus, to maintain the financial stability of the utility, the revenue reduction due to the lifeline rate must be compensated with tariff increases in other categories. With the purpose of not affecting the competitiveness of productive customer groups, we propose a cross subsidy mechanism internal to the Residential customer category.

Base Case

From the ZESCO customer database, in 2018 the average household consumption is above 300kWh/month, and therefore all customers in the second block (50 to 300 kWh/month) have below average consumption. So as not to affect the affordability of lower-than-average customers, we will keep this second block neutral to the cross subsidy proposed and recover the cost of the subsidy from the highest consumption (and consequently highest income) block of more than 300 kWh/month.

The following table shows the amount and allocation of absolute subsidies derived from the assumed lifeline rate for each year of the period 2021-25:

Subsidies allocation per Residential consumption block

	Subsidies received by block (USD 2019 million)				
Consumption block (kWh/month)	**2021**	**2022**	**2023**	**2024**	**2025**
0 - 50	50.2	54.7	56.3	56.0	58.4
50 - 300	-	-	-	-	-
> 300	(50.2)	(54.7)	(56.3)	(56.0)	(58.4)

Source: EMRC

The following table presents the annual evolution of residential tariffs applying the life-line subsidy, and the average along the period 2021-25:

Residential tariffs applying life line cross subsidy

Consumption			Residential Tariff (USD/MWh)						Average Subsidized Tariff (ZMW/kWh)
Tier	**kWh/month**		**2021**	**2022**	**2023**	**2024**	**2025**	**AVG 2021-25**	**AVG 2021-25**
1	-	50	44.4	46.9	46.4	44.0	43.9	45.1	0.56
2	50	300	186.0	196.2	194.3	183.9	183.8	188.8	2.34
3	300	-----	264.3	278.9	276.1	261.5	261.2	268.4	3.33

Source: EMRC

Comparing with cost reflective charges, the proposed cross- subsidised arrangement of tariffs results in an internal tariff structure per consumption block in which the average charge for the lifeline block is 4 times lower than cost-reflective, and with the average charge for the high consumption block being 42% higher than cost reflective (as seen in next table):

Subsidized tariffs compared with cost reflective and current tariffs

Consumption			Subsidized Tariff (ZMW/kWh)	Cost Reflective Tariffs (ZMW/kWh)	Current tariffs ERB (ZMW/kWh)	Subsidized/Cost Reflective	Subsidized/Current Tariffs
Tier	**kWh/month**		**AVG 2021-25**	**AVG 2021-25**	**2020**		
1	-	50	0.56	2.34	0.47	0.24	1.19
2	50	300	2.34	2.34	0.85	1.00	2.76
3	300	999,999	3.33	2.34	1.94	1.42	1.72

Source: EMRC

With respect to current tariffs, the final cross subsidized charges would represent an increase of 19% for the lifeline block, an increase of 176% for the mid-consumption block, and an increase of 72% for the high consumption block (as can be seen in the previous table).

Alternative Case

An alternative case of two IBT blocks was analysed: Lifeline consumption of 50 kWh/month and a second consumption block above 50 kWh/month.

The following table illustrates the absolute amount of subsidy that results for each year of the period 2021-25:

Subsidies allocation per residential consumption blocks. Two blocks.

	Subsidies received by block (USD 2019 million)				
Consumption block (kWh/month)	**2021**	**2022**	**2023**	**2024**	**2025**
0 - 50	50.2	54.7	56.3	56.0	58.4
> 50	(50.2)	(54.7)	(56.3)	(56.0)	(58.4)

Source: EMRC

The following presents the annual evolution of residential tariffs applying the life-line subsidy, and the average along the period 2021-25:

Residential tariffs applying life line cross subsidy. Two blocks.

Consumption			Residential Tariff (USD/MWh)						Average Subsidized Tariff (ZMW/kWh)
Tier	**kWh/month**		**2021**	**2022**	**2023**	**2024**	**2025**	**AVG 2021-25**	**AVG 2021-25**
1	-	50	44.4	46.9	46.4	44.0	43.9	45.1	0.56
2	50	-----	211.2	222.9	220.7	208.9	208.7	214.5	2.66

Source: EMRC

Comparing with cost reflective charges, the proposed cross- subsidised arrangement of tariffs results in an internal tariff structure per consumption block in which the average charge for the lifeline block is 4 times lower than cost-reflective, and with the average charge for the high consumption block being 13% higher than cost reflective (as can be seen in the following table):

Subsidized tariffs compared with cost reflective and current tariffs. Two blocks.

Consumption			Subsidized Tariff (ZMW/kWh)	Cost Reflective Tariffs (ZMK/kWh)	Current tariffs ERB (ZMW/kWh)	Subsidized/Cost Reflective	Subsidized/ Current Tariffs
Tier	**kWh/month**		**AVG 2021-25**	**AVG 2021-25**	**2020**		
1	-	50	0.56	2.34	0.47	0.24	1.19
2	50	----	2.66	2.34	1.94	1.14	1.37

Source: EMRC

With respect to current tariffs, the final cross subsidized charges would represent an increase of 19% for the lifeline block, and an increase of 37% for the high consumption block (table above).

The impact with respect to current tariffs in the upper block is lower than in the case of three consumption blocks. However, as previously said, this alternative has the drawback that it penalizes households that consume less than the average monthly consumption (326kWh) at a very high rate (2.66/0.85, more than 300%).

A similar situation would happen with three consumption blocks 0-50/50-100/>100kWh/month.

We therefore recommend the alternative of three blocks, with 50 and 300kWh/month limits as the most sensible in terms of simplicity and fairness, with moderate differences with respect to the cost reflective tariff level.

1.7. Conclusions

The analysis has shown a clear case for the introduction of a lifeline tariff in Zambia. Our analysis based on the Living Conditions Monitoring Survey of the Zambian Central Statistics Office shows that 54% of the households in the country would not be able to afford the Basic Consumption Needs (BCN) of 50 kWh/HH/month under an eventual cost reflective tariff structure, and can hardly afford this level of consumption under the current tariffs.

Thus the new tariff structure would address not only the issue of access and cost-reflectivity but affordability as well. Globally in both developing and developed countries affordability has been addressed by various subsidy mechanisms and consumption targeted lifeline tariffs has been found to be the most effective.

A lifeline tariff for households that consume less than 50 kWh would adequately address the basic energy necessities of poor households in Zambia and lead to an improvement in the standard of living.

The analysis has shown that a lifeline tariff of 0.57 ZMW/kWh would allow customers under the poverty line to reasonably afford to pay for electricity and we therefore propose such a lifeline tariff for the lower consumption block below 50kWh/month under the increasing blocks regime (IBT) already in place.

The analysis has demonstrated the impact on other tariffs and provided an indication of the order of magnitude of increases in the highest consumption block of the Residential tariff (above 300 kWh/month) if the cross subsidy is to be recovered through over charges on this sub-group of customers, asuming the subsidy is not recovered from customers in the mid block (100-300kWh).

We note that availability of basic information about energy needs and consumption of Zambian households would enable a more accurate estimate of basic consumption needs (in this study assumed to be 50kWh), and furthermore provide a more solidly based estimation of the lifeline rate.

2. Introduction

According to the Terms of Reference, the objective of this report is to:

- Determine the level of electricity requirement for low income households in Zambia for basic needs.
- Determine an income/electricity expenditure ratio for low income households in Zambia, and propose a tariff level for low income household consumers, including the appropriate quantity of electricity required for basic needs; and
- Determine the economic cost differential between the proposed life-line tariff and the economic cost of supply to the household category, and provide recommendations on how the life-line tariff subsidy could be paid for without government transfers and reduction in revenues of the utility.

When implementing a life line tariff scheme, particular attention must be given to properly define electricity affordability. Affordability is related to the ability of certain consumers or groups of consumers to pay a minimum level of service. Therefore, affordability is a concept closely related to poverty.

Electricity affordability is assessed through the portion (share) of monthly income or expenses of households that is spent on electricity service. The use of household expenditure rather than income tends to provide a more accurate assessment when informal income generating activity represents a part of household income.

First, a referential value (threshold) of affordability must be defined. Although there is no universal benchmark, an acceptable threshold for electricity to be considered for Zambia is to be in the range of 5% of poor household expenditures. This percentage is the benchmark proposed by the World Bank for the poorest households[2].

Then it is necessary to define a level of subsistence electricity consumption or some other value considered acceptable. From this information it is possible to determine an average tariff value that is affordable for the household/consumer.

After defining these parameters, the overall amount of the subsidy that needs to be recovered can be estimated through increases in charges in other tariff categories. In order to do this, the implementation of 3 blocks of consumption in the domestic tariff is proposed.

This report is structured as follows:

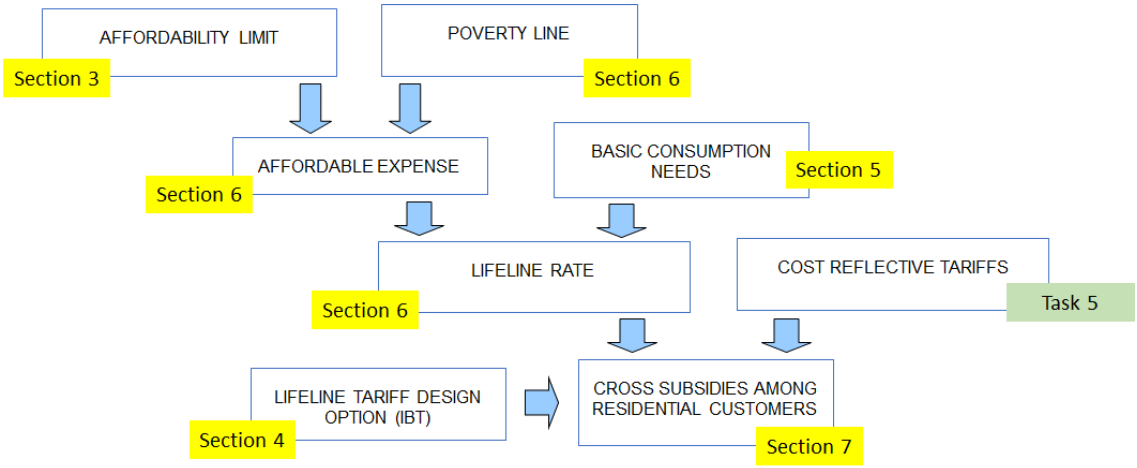
- Section 1 presents an Executive Summary of the report, and Section 2 is this Introduction.
- Section 3 presents the concept of affordability and its application for the Lifeline tariff estimation.
- Section 4 presents Lifeline tariff design options from a conceptual point of view.

[2]Making Power Affordable for Africa and Viable for Its Utilities (WB/ADB/ESMAP – 2016)

- In Section 5 we estimate the Basic Consumption Needs of a Zambian household.
- In Section 6 we compute a Lifeline Energy rate for an average household below the poverty line.
- In Section 7 we simulate the impact of the Lifeline rate on the residential tariff structure, with the purpose of recovering the tariff revenue reduction implicit in the Lifeline rate, considering as an input the cost reflective tariffs estimated in Task 5.
- Section 8 presents the main conclusions of the study.

The following diagram represents the general approach for the task and how it is addressed along the report:

Figure 1 – General Approach of the Task



3. Affordability

Sub-Saharan Africa (SSA) lags behind all other regions of the world in electricity generation capacity, per capita electricity consumption, and household access to electricity. Two important determinants of whether the region's electricity sector will be able to meet demand and expand access are the financial sustainability of utilities and the ability of households to afford tariffs.[3]

Affordability is estimated as the share of monthly household income spent on utility services, such as electricity, heating and water. It is often assessed more precisely as an affordability ratio - the share of utility payments in total household expenditures. Using household expenditures rather than income tends to provide more accurate information, as household income data rarely captures all sources of revenue. This is particularly the case in countries where informal income generating activities provides a substantial share of household income, which is the case in Zambia. In these countries, expenditure is a more reliable indicator of the resources available for households to afford utility services.[4]

Although there is no universal benchmark, a WB study summarized in Table 1 below shows that in general the threshold among SSA countries is around 4% of household expenditures for electricity.

[3] Making Power Affordable for Africa and Viable for Its Utilities (WB/ADB/ESMAP – 2016)

[4] Fankhauser, Samuel and Tepic, Sladjana (May 2005). Can por consumers pay for energy and water? An affordability analysis for transition countries. European Bank for Reconstruction and Development. Wingler, Harald; Simoes, André Felipe; Lebre La Rovere, Emilio; Atiq Rahman, Mozaharul Alam and Mwakasonda, Stanford (2011). Access and affordability of electricity in Developing countries. World Development Vol. 39, N° 6, pp. 1037 - 1050.

Table 1 - Household Expenditure Percentages on Electricity in African Sub-Saharan Region

Country	All households			Poor		
	Urban	Rural	Total	Urban	Rural	Total
Angola	4,0	2,9	4,0	5,6	4,2	5,5
Botswana	6,2	7,6	6,5	9,5	11,1	9,8
Burkina	4,6	4,1	4,5	6,2	3,3	5,2
Cote	2,5	2,4	2,5	3,1	3,0	3,1
Ethiopia	2,8	1,3	2,2	4,6	2,4	3,7
Ghana	2,6	2,0	2,4	3,1	2,4	2,7
Madagascar	4,4	4,1	4,3	4,1	3,7	3,9
Malawi	0,3	0,3	0,3	0,4	0,4	0,4
Mali	2,9	1,4	2,2	2,4	1,2	1,4
Mozambique	3,7	4,0	3,7	6,1	7,5	6,4
Niger	3,4	2,4	3,2	2,8	1,9	2,2
Nigeria	2,6	2,3	2,5	3,1	2,7	2,9
Rwanda	1,4	1,6	1,5	2,3	3,3	2,9
São Tomé and Príncipe	2,0	1,9	2,0	2,3	2,1	2,2
Senegal	3,7	3,6	3,7	3,7	3,5	3,6
Sierra Leone	4,5	9,1	4,6	4,9	13,2	5,2
South Africa	5,3	5,2	5,3	7,3	6,0	6,6
Swaziland	9,5	9,1	9,3	13,9	10,9	11,9
Tanzania	3,0	3,3	3,1	1,9	5,8	3,1
Togo	3,1	3,1	3,1	3,6	3,3	3,5
Uganda	2,4	1,9	2,4	0,0	3,6	3,6
Zambia	5,4	6,3	5,5	8,3	5,4	7,8
Average	**3,7**	**3,6**	**3,6**	**4,5**	**4,6**	**4,4**

Source: World Bank, 2016[5]

A comparative table of proportions of expenditures by households on electricity across the Sub-Saharan countries indicates an average of about 4.4% for poor households and 3.6% for all households. For the purpose of defining the Lifeline Tariff for Zambia, we will adopt 3.6% (i.e the all household's average of the region) as the affordability limit, thereby providing a fair target, at the average regional level, for the electricity consumption burden on poor households' expenditures.

[5] Masami Kojima; Xin Zhou; Jace Jeesun Han; Joeri de Wit; Robert Bacon; Chris Trimble. August 2016. Who Uses Electricity in Sub-Saharan Africa? Findings from Household Surveys. Policy Research Working Paper 7789. Energy and Extractives Global Practice Group. World Bank Group.

4. Lifeline Tariff Design Options

To fully determine the Life Line tariff level it is first necessary to establish the source of funding of the subsidy that customers under life-line consumption are going to receive.

Subsidies can be directly financed by the government from general tax revenues, or regulators can make use of cross-subsidization within their electricity customer base. Even though direct finance fom the government to households may be desirable because it does not distort the efficient pricing structure, its implementation requires complex fiscal procedures and accurate and updated information on households wealth situation that imposes a significant burden on developing countries in Latin America and SSA. This is why costs (or lost revenue by the utility) as a result of the application of the lifeline tariff are usually recovered through cross-subsidisation within the electricity tariff structure.

4.1. Cross Subsidies

More specifically, in a tariff structure that is fully cost-reflective the introduction of a lifeline tariff would require one or more of the other tariffs to be higher than their cost-reflective level so that the income lost to the utility from the application of the lifeline tariff is recovered from other tariff category consumers. The Electricity Act 11, 2019 and the Energy Regulation Act 12, 2019 establish the legal framework for tariff setting in Zambia, within which the Regulator will guarantee cost-reflective tariffs that ensure financial viability and a sustainable, reliable and quality electricity supply. Within this framework there is no ban on cross subsidies internal to customer categories to address social equity goals.

Industrial and commercial customers can be selected to provide the cross-subsidies to the life-line tariff households. However such a cross-subsidisation can have long-term negative impacts on the competitiveness of business especially for electricity intensive industries. To avoid such negative commercial effects it is preferable if the cross-subsidisation is carried out between low- and high-income households rather than from industrial or commercial customer categories. Moreover, reasonably high tariffs are found to restrain electricity waste and promote energy efficiency in higher income households. The draw back of this approach is however that the small higher income population may be over-burdened and hence reduce their consumption below what was planned in tariff setting, resulting in a shortfall in utility revenues.

To be effective and practical, tariff reforms need to benefit a large majority of the population, not only customers of the utility company. If this principle is not followed then tariff reviews may lead to unrest. There have been instances of regulatory approved increases being reversed and alternative measures, such as the introduction of subsidies being implemented. Therefore, experience has shown that it helps to be pro-active and consider all possible measures when reforming tariffs to address fuel poverty.

Consequently, we suggest life line tariffs be designed and applied not just for current ZESCO low income customers but for all low income households in the country.

4.2. Increasing Block Tariffs (IBT)

The most common system for introducing a lifeline tariff is based on the first tranche of consumption. This type of regime is called **Increasing Block Tariffs** (IBTs), where consumers face higher unit prices on higher blocks of consumption. The first block is the lifeline tariff. Multiple blocks are often used for household customers with some or all of the higher consumption blocks having tariffs that are more than the cost-reflective level. The current ZESCO tariff schedule has three blocks with the lowest consumption level block having a lower tariff which is referred to as lifeline. Households consuming more than the lifeline threshold level will be subsidising the lifeline households with the amount of subsidy directly proportional to the level of consumption.

An important advantage of the IBT regime is that because all customers pay the same tariff for the first tranche of consumption there is no necessity for an enforcement mechanism or a system of penalties to deter abuse of the lifeline mechanism.

4.3. Volume Differentiated Tariffs (VDT)

If the IBT structure is designed so that block prices increase too slowly with higher volumes, cost recovery is compromised even for higher blocks, and better-off households benefit from the subsidies. An alternative design is the **Volume-Differentiated Tariff**s (VDTs) where kWh consumption above a threshold leads to a higher price on all consumption. The VDT structure is an effective method to efficiently target lifeline blocks, thus reducing costs associated with subsidy schemes for the poorest. Regardless of the pricing mechanism, correct calibration of block sizes and associated price levels requires a good knowledge of consumption patterns. In addition to this, there are very sharp tariff increases when moving into a higher consumption block, generating undesirable variability in tariffs faced by customers.

4.4. IBT Subsidies Structure for Zambia

The IBT system is the most commonly applied particularly in the developing world and is currently applied in Zambia. VDT would require significant advances in the metering endowment in Zambian residential customers (currently almost 100% pre-paid) and would represent a drastic change to the current regime. We are therefore assuming and recommend that the IBT system will continue to be applied in Zambia.

5. Definition of Basic Consumption Needs

The volume of consumption to be subsidized varies across countries and regions. Table 2 lists some relevant examples of subsidized electricity consumption under lifeline rates (social tariff regimes) by country.

Table 2 - Social Tariff Subsidized Electricity Consumption. African Sub-Saharan Region[6]

Country	Monthly Consumption for Social Tariff
Angola	TS1=120 KWh / TS2=200 KWh
Mozambique	100 KWh
Togo	40 KWh
Tanzania	75 KWh
South Africa	150 KWh
Nigeria	50 KWh
Niger	50 KWh
Ghana	50 KWh
Gabon	TS1=120 KWh / TS2=240 KWh
Benin	20 KWh

Source: World Bank, 2016

According to the survey developed by the Energy and Extractives Global Practice Group of the World Bank, (source of the examples in Table 2), the most common lifeline block size is 50 kWh[7], followed by 25, 75, and 100 kWh.

Given the non-existence of recent energy consumption surveys or information on Zambian households to determine a level of basic consumption needs applicable for this study, we are going to assume indirect references from SSA (presented in Table 2). Therefore, referring to the literature on regional energy needs in southern countries of Africa[8], a referential consumption of 50 kWh/month can be adopted as the Basic Consumption Needs level to apply for the lifeline rate estimation in Zambia.

[6] Masami Kojima; Xin Zhou; Jace Jeesun Han; Joeri de Wit; Robert Bacon; Chris Trimble. August 2016. Who Uses Electricity in Sub-Saharan Africa? Findings from Household Surveys. Policy Research Working Paper 7789. Energy and Extractives Global Practice Group. World Bank Group.

[7] Ibid. The survey covers an analysis of residential tariffs for 39 countries in the African Sub-Sahara Region including 22 countries with household survey data.

[8] Davidson O. and Mwakasonda S. A., 2004, Electricity access for the poor: a study of South Africa and Zimbabwe, Energy for Sustainable Development VIII (4)/ Winkler, H., et. al., 2011. Access and Affordability of Electricity in Developing Countries, World Development 39 (6)

According to our experience, this regional reference of 50kWh/month Basic Consumption Needs may be approximately disaggregated between four main groups of uses (lighting, radio, cell phones and cooking/water heating/ironing) as presented in the following table:

Table 3 – Dissagregation of Basic Consumption Needs

Use	h/day	# devices	W/device	days	Total (kWh)
Lighting	5.00	2	60.0	30	18.0
Radio	10.00	1	3.0	30	0.9
Cell phones	1.00	2	4.0	30	0.2
Cooking/water heating/ironing	1.03	1	1,000	30	30.9
TOTAL					**50.0**

Source: EMRC estimations

The following Table 4 presents the number of households and consumption levels under the 50kWh proposed lifeline block and the current 100 kWh lower consumption block:

Table 4 - Volume of subsidized energy sales for domestic customers for 50 and 100/kWh definition of basic electricity needs

Basic Consumption Needs	50 kWh/month	100 kWh/month
Numbers of Residential customers within basic needs band	22,908	40,167
Numbers of Residential customers that consume more than the basic needs band	691,248	673,989
Residential customers within basic needs band	3.2%	5.6%
Average life-line consumption (kWh/month)	35.2	53.7
Total average consumption (kWh/month)	326.9	326.9
Total basic needs consumption (kWh/month)	807,332	2,157,776
Total consumption - all domestic customers (kWh/month)	233,440,393	233,440,393
Basic Consumption Needs as a % of total residential consumption	0.35%	0.92%

Source: EMRC estimation based on ZESCO information (2018)

The share of subsidized sales in case of 50 and 100 kWh/month lifeline consumptions, derive from the consumption distribution estimated on the customers data base of 2018:

Table 5 - Consumption Distribution

Customer consumption (kWh/month)	Consumption share	Accumulated consumption share
0-35	0.09%	0.09%
35-50	0.26%	0.35%
50-75	0.18%	0.53%
75-100	0.40%	0.92%
100-200	7.67%	8.59%

200-300	29.72%	38.31%
300-1,000	48.47%	86.78%
1,000-2,000	6.89%	93.67%
2,000-5,000	4.33%	98.00%
> 5,000	2.00%	100.00%

Source: EMRC (based on 2018 ZESCO customer data base)

The analysis presented in Table 4 shows that the subsidized number of customers and their energy consumption in 2018 was moderate and therefore would be relatively easy to accommodate within the ZESCO system. However, the impact may become more important in the future because the number of low-income end users from rural areas that will be connected to the grid may increase significantly as connection programmes develop. The level of subsidies will increase *pari passu* as the number of low-income end users connected to the grid increases. Thus, the financial burden of subsidies will need to be monitored closely on a regular basis particularly if grid-connected electrification adds large numbers of low-income households to the network.

6. Definition of a Lifeline Energy Rate

In this section we describe the analysis to determine a tariff level that will make basic electricity needs affordable for a majority of low-income households. As noted earlier we actually use household expenditure rather than income statistics as it is a more accurate indicator in the low-income sector where there are often various and disparate sources of income for households.

6.1. Estimation of Household Expense

Statistical surveys on living conditions and welfare from the Central Statistical Office were analyzed. The last Living Conditions Monitoring Survey surveys household expenditure information for 2015 shows the following distribution:

Table 6 - Household expenditure by quintile

Quintile	Households	AVG monthly exp. (ZMW/month)	AVG household size (AE)	AVG exp. (ZMW/AE/month)
Q1	20%	227.0	4.4	72.0
Q2	20%	486.0	4.9	133.0
Q3	20%	842.0	5.2	218.0
Q4	20%	1,525.0	5.3	374.0
Q5	20%	4,856.0	5.8	1,144.0
Total	100%	1,588.0	5.1	388.0

Source: LCMS 2015[9]

Some basic definitions are relevant at the time of analyzing the results in Table 6:

- Household Monthly Expenditure: household members' monthly expenditure on goods and services for consumption. It can be defined as the sum of all expenditure of household members.
- Household Monthly Average Expenditure: household's monthly expenditure on goods and services for consumption. It is calculated as the total monthly expenditure of all households divided by the total number of households.
- Average Per Capita Monthly Expenditure: average per capita monthly expenditure denotes the average monthly expenditure of a household member. It is calculated as the total household monthly expenditure divided by the total number of persons in the household.

[9] Please note that the average expenditure per adult equivalent is different than the division of average expenditure and average adults equivalent (the three are independent survey variables).

- Adult Equivalent (AE): equivalent number of adults living in the household, adding children according to their age (with associated equivalence factors).

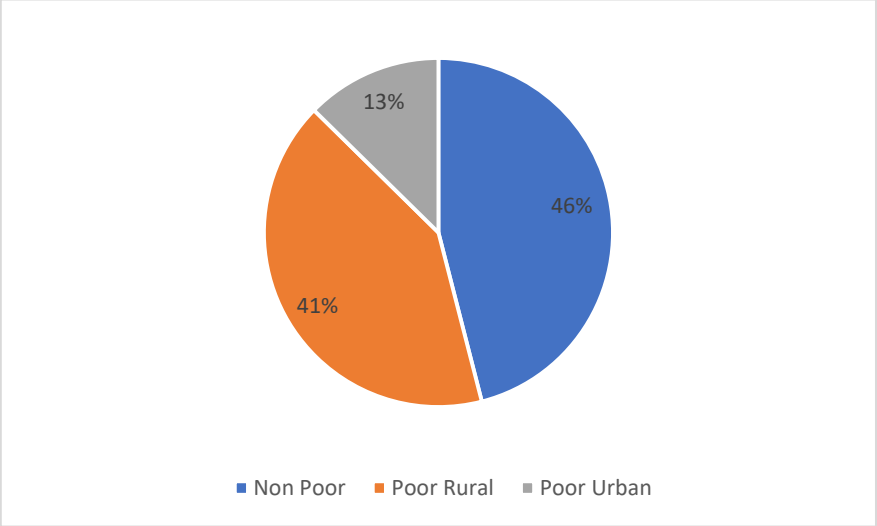
6.2. Poverty Line and Affordable Household Expense

Absolute poverty: uses a poverty line based on a fixed expenditure or consumption level. Absolute poverty lines typically specify the amount of money that is required to meet a minimum standard of living, such as basic nutritional requirements and essential non-food necessities (basic clothing, housing, etc.). In general, the CSO uses the Cost of Basic Needs approach when measuring absolute poverty.

The CSO method starts by determining the cost of a simple food basket that meets minimal nutritional requirements. The 2015 food basket was valued at K152 per Adult Equivalent. A person also requires other essential goods and services for his or her well-being. In view of these additional requirements, the overall (moderate) poverty line considers other non-food needs. In the 2015 LCMS report, a non-food poverty line was valued at K62 per AE. Thus combining minimum needs of food K152 and non-food K62 to make a total 214 ZMW/AE/month as the 2015 poverty line.

Figure 2 shows the incidence of poverty by type of household. At national level, the incidence of poverty was estimated at 54.4%. Results also reveal that poverty in Zambia is more of a rural than an urban phenomenon. In rural areas the proportion of the population that is considered to be below the poverty line in 2015 remained at the 2010 level of about 76%, whereas in urban areas it is 23.4%.

Figure 2 - Poverty per type of household



Source: LCMS 2015

When considering extreme poverty, the gap between urban and rural households is even higher, as can be seen in Table 7:

Table 7 - National wide poverty distribution

	Overall poverty			Extreme poverty		
	Incidence	Depth	Severity	Incidence	Depth	Severity
Zambia	54.4	26.4	16.0	40.8	17.5	9.8
Rural	76.6	39.2	24.3	60.8	26.8	15.1
Urban	23.4	8.5	4.5	12.8	4.6	2.3
Central	56.2	25.5	14.6	39.8	15.8	8.2
Copperbelt	30.8	11.8	6.1	18.2	6.3	3.1
Eastern	70.0	34.7	21.1	55.9	23.0	12.8
Luapula	81.1	45.4	29.5	67.7	32.7	19.3
Lusaka	20.2	7.1	3.7	11.0	3.9	1.9
Muchinga	69.3	35.9	22.3	54.4	24.8	13.8
Northern	79.7	45.2	30.0	67.6	33.3	20.2
North Western	66.4	30.2	17.5	48.4	19.3	10.0
Southern	57.6	24.3	13.6	38.1	14.6	7.6
Western	82.2	47.4	31.2	73.0	34.9	20.5

Source: LCMS 2015

To determine the average income of a household in poverty it is therefore necessary to consider the average expenditure in the households in the quintiles with a per capita income lower than 214 ZMW/AE/month. Table 8 shows the comparison using the data presented in Table 6:

Table 8 – Expenditure quintiles below poverty line

Quintile	Households	AVG monthly exp. (ZMW/month)	AVG household size (AE)	AVG exp. (ZMW/AE/month)	
Q1	20%	227.0	4.4	72.0	
Q2	20%	486.0	4.9	133.0	Poverty line 214.0 ZMW/AE/month
Q3	20%	842.0	5.2	218.0	
Q4	20%	1,525.0	5.3	374.0	
Q5	20%	4,856.0	5.8	1,144.0	
Total	100%	1,588.0	5.1	388.0	

Source: EMRC based on LCMS 2015

Thus, the average expenditure in quintiles below the poverty level of 214 ZMW/AE/month corresponds to the average of Q1, Q2 and Q3 quintiles: 141/AE/month (average poverty expenditure).

Table 9 presents the adjustment of this figure by inflation to 2019 ZMW, and then multiplying by the average household size in Q1, Q2 and Q3 (4.8 AE/HH), deriving a final figure for poverty level household expenditure of 939.5 ZMW/HH:

Table 9 - Average household expenditure under poverty line (2019)

	Inflation %	AVG pov. exp. (ZMW 2015 /AE)	AE/HH	AVG pov. exp. (ZMW 2019 /HH)
2015		141.0		
2016	10.11	155.3		
2017	6.58	165.5		
2018	6.99	177.0		
2019	9.15	193.2	4.8	934

Source: EMRC based on LCMS 2015/Inflation: https://www.statista.com

Therefore, considering the maximum affordability ratio of 3.6% defined in Section 3, the maximum affordable household expenditure on electricity for an average household below poverty line is therefore 3.6% of 939.5 ZMW/month = 33.80 ZMW/month in 2019 ZMW.

As per ERB tariff schedule, applicable taxes are 3% excise duty and 16% VAT, so the affordable monthly household expenditure excluding taxes is 28.3 ZMW.

Thus the level of consumption equal to the life-line threshold of 50 kWh may be afforded by an average household below poverty line if a life-line tariff is set at or below 0.56 ZMW/kWh (exclusive of taxes). Lower consumptions would reach electricity expenditure shares below 3.6%.

6.1. Lifeline Energy Rate

It can be seen in following Table 10 that cost reflective tariffs estimated in Task 5 are above affordable rates for average households below the poverty line.

Table 10 - Affordability with current ZESCO and Cost Reflective tariffs

	ZMW/kWh (excluding taxes)	ZMW/kWh (including taxes)	kWh/month	ZMW/month	Electricity expenditure share of total household expenditure
Current ZESCO Tariff (0-100 kWh/month)	0.47	0.57	50	28.1	3.0%
			100	56.2	6.0%
Cost Reflective Tariff (0-100 kWh/month)	1.06	1.27	50	63.3	6.7%
			100	126.6	13.5%

Source: EMRC

Table 10 also shows that current ZESCO tariffs lead to an expenditure share for customers in the lifeline block of 3% which is slightly below the affordability ratio of 3.6%.

As a conclusion, we will consider a Lifeline Rate of 0.56 ZMW/kWh (exclusive of taxes) for a basic needs consumption of 50 kWh/month, to guarantee minimum electricity affordability for an average household below the poverty line, under the current socio-economic conditions (as per 2019 poverty line).

7. Cross Subsidy Among Residential Customers

7.1. Base Case. Three consumption blocks.

This section presents an analysis of the impact on ZESCO tariff structure of:

- Lifeline consumption (Basic Needs Consumption) of 50 kWh/month (Section 5)
- Defining a Lifeline energy rate of 0.56 ZMW/kWh (exclusive of taxes – 2019 ZMW) (Section 6)

As presented in section 6, the Lifeline rate of 0.56 ZMW/kWh is significantly lower than the cost reflective energy rate of 1.06 ZMW/kWh computed in Task 5 for the first consumption block (50 kWh/month), and of course well below the common residential cost reflective 2.34 ZMW/kWh. According to the projections for the tariff review period (2021-2025), applying the lifeline tariff to consumptions below 50kWh would result in a reduction of expected revenue from this lower block.

To maintain the financial stability of the utility, this revenue reduction must be compensated by an increased revenue from other sources. As proposed in Section 4.1, so as not to affect the competitiveness of productive industrial and commercial customer groups, we propose a cross subsidy mechanism internal to the Residential customer category.

As the average household consumption is 327kWh/month, all customers in the second block have below average consumption. So as not to affect the affordability of lower-than-average customers we propose to keep the second block (51-300 kWh/month) neutral to the cross subsidy proposed and recover the subsidy from the highest consumption (and consequently highest income) block of more than 300 kWh/month.

Table 11 illustrates the absolute amount of subsidy that results for each year of the period 2021-25:

Table 11 - Subsidies allocation per residential consumption block. Three blocks.

	Subsidies received by block (USD 2019 million)				
Consumption block (kWh/month)	2021	2022	2023	2024	2025
0 - 50	50.2	54.7	56.3	56.0	58.4
50 - 300	-	-	-	-	-
> 300	(50.2)	(54.7)	(56.3)	(56.0)	(58.4)

Source: EMRC

Table 12 presents the annual evolution of residential tariffs applying the life-line subsidy, and the average along the period 2021-25:

Table 12 - Residential tariffs applying life line cross subsidy. Three blocks.

Consumption			Residential Tariff (USD/MWh)						Average Subsidized Tariff (ZMW/kWh)
Tier	**kWh/month**		**2021**	**2022**	**2023**	**2024**	**2025**	**AVG 2021-25**	**AVG 2021-25**
1	-	50	44.4	46.9	46.4	44.0	43.9	45.1	0.56
2	50	300	186.0	196.2	194.3	183.9	183.8	188.8	2.34
3	300	-----	264.3	278.9	276.1	261.5	261.2	268.4	3.33

Source: EMRC

Comparing with cost reflective charges, the proposed cross- subsidised arrangement of tariffs results in an internal tariff structure per consumption block in which the average charge for the lifeline block is 4 times lower than cost-reflective, and with the average charge for the high consumption block being 42% higher than cost reflective (as can be seen in Table 13):

Table 13 – Subsidized tariffs compared with cost reflective and current tariffs. Three blocks.

Consumption			Subsidized Tariff (ZMW/kWh)	Cost Reflective Tariffs (ZMK/kWh)	Current tariffs ERB (ZMW/kWh)	Subsidized/Cost Reflective	Subsidized/ Current Tariffs
Tier	**kWh/month**		**AVG 2021-25**	**AVG 2021-25**	**2020**		
1	-	50	0.56	2.34	0.47	0.24	1.19
2	50	300	2.34	2.34	0.85	1.00	2.76
3	300	999,999	3.33	2.34	1.94	1.42	1.72

Source: EMRC

With respect to current tariffs, the final cross subsidized charges would represent an increase of 19% for the lifeline block, an increase of 176% for the mid-consumption block, and an increase of 72% for the high consumption block (as can be seen in Table 13).

The impact with respect to current tariffs is much higher and more focused on the mid-block, due to the need to remove the significant cross subsidy residential tariffs currently have at the expense of industrial and commercial customers.

7.2. Alternative Case. Two consumption blocks.

This section presents an analysis of the impact on ZESCO tariff structure of an alternative case, in which two IBT consumption blocks are established:

- Lifeline consumption (Basic Needs Consumption) of 50 kWh/month
- A second consumption block above 50 kW/month

Table 14 illustrates the absolute amount of subsidy that results for each year of the period 2021-25:

Table 14 - Subsidies allocation per residential consumption blocks. Two blocks.

	Subsidies received by block (USD 2019 million)				
Consumption block (kWh/month)	2021	2022	2023	2024	2025
0 - 50	50.2	54.7	56.3	56.0	58.4
> 50	(50.2)	(54.7)	(56.3)	(56.0)	(58.4)

Source: EMRC

Table 15 presents the annual evolution of residential tariffs applying the life-line subsidy, and the average along the period 2021-25:

Table 15 - Residential tariffs applying life line cross subsidy. Two blocks.

Consumption			Residential Tariff (USD/MWh)						Average Subsidized Tariff (ZMW/kWh)
Tier	**kWh/month**		**2021**	**2022**	**2023**	**2024**	**2025**	**AVG 2021-25**	**AVG 2021-25**
1	-	50	44.4	46.9	46.4	44.0	43.9	45.1	0.56
2	50	-----	211.2	222.9	220.7	208.9	208.7	214.5	2.66

Source: EMRC

Comparing with cost reflective charges, the proposed cross- subsidised arrangement of tariffs results in an internal tariff structure per consumption block in which the average charge for the lifeline block is 4 times lower than cost-reflective, and with the average charge for the high consumption block being 13% higher than cost reflective (as can be seen in Table 16):

Table 16 – Subsidized tariffs compared with cost reflective and current tariffs. Two blocks.

Consumption			Subsidized Tariff (ZMW/kWh)	Cost Reflective Tariffs (ZMK/kWh)	Current tariffs ERB (ZMW/kWh)	Subsidized/ Cost Reflective	Subsidized/ Current Tariffs
Tier	**kWh/month**		**AVG 2021-25**	**AVG 2021-25**	**2020**		
1	-	50	0.56	2.34	0.47	0.24	1.19
2	50	----	2.66	2.34	1.94	1.14	1.37

Source: EMRC

With respect to current tariffs, the final cross subsidized charges would represent an increase of 19% for the lifeline block, and an increase of 37% for the high consumption block (as can be seen in Table 16).

The impact with respect to current tariffs in the upper block is lower than in the case of three consumption blocks. However, as previously said, this alternative has the drawback that penalizes households under average monthly consumption (326kWh) at a very high rate (2.66/0.85, more than 300%).

Similar situation would happen with three consumption blocks 0-50/50-100/>100kWh/month.

From our point of view, the alternative of three blocks, with 50 and 300kWh/month limits is the most sensible in terms of simplicity and fairness, with moderate differences with respect to the cost reflective tariff level.

8. Conclusions

The analysis has shown a clear case for the introduction of a lifeline tariff in Zambia. Our analysis based on the Living Conditions Monitoring Survey of the Zambia Statistics Agency shows that 54% of the households in the country would not be able to afford the Basic Consumption Needs (BCN) of 50 kWh/HH/month under an eventual cost reflective tariff structure, and can hardly afford this level of consumption under the current tariffs.

Thus, the new tariff structure would address not only the issue of cost-reflectivity but affordability as well. Globally in both developing and developed countries affordability has been addressed by various subsidy mechanisms and consumption targeted lifeline tariffs has been found to be the most effective.

A lifeline tariff for households that consume less than 50 kWh would adequately address the basic energy necessities of poor households in Zambia and lead to an improvement in their standard of living.

The analysis presented in Section 6 has shown that a lifeline tariff of 0.57 ZMW/kWh would allow customers under the poverty line to reasonably afford to pay for electricity and we therefore propose such a lifeline tariff for the lower consumption block below 50kWh/month under the increasing blocks regime (IBT) already in place.

The analysis has demonstrated the impact on other tariffs and provided an indication of the order of magnitude of increases in the highest consumption block of the Residential tariff (above 300 kWh/month) if the cross subsidy is to be recovered through over charges on this sub-group of customers, asuming the subsidy regime does not recover subsidy from customers in the mid block (50-300kWh).

We note that availability of basic information about energy needs and consumption of Zambian households would allow to more accurately estimate basic consumption needs (in this study assumed to be 50kWh), and furthermore provide a more solidly based estimation of the lifeline rate.